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APPLICATION OF EARTH RESOURCES TECHNOLOGY SATELLITE

DATA TO URBAN DEVELOPMENT AND REGIONAL PLANNING:

TEST SITE - COUNTY OF LOS ANGELES. SR 124

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**Details of illustrations in
this document may be better
studied on microfiche**

March 10, 1973

Second Bi-Monthly Progress Report
for Period January-February, 1973

Prepared for

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PROGRAM OBJECTIVES - RESULTS REVIEW

Substantial results directly corroborating program objectives, namely to assess utility of ERTS data for planning, to evaluate techniques and products from GEMS (General Electric Multispectral Information Extraction System) and to develop planning methodologies were obtained during this reporting period.

The Data Analysis Plan, based on the 'first look' study of four cycles of imagery, was prepared, submitted and accepted during the same period.

An intensive activity of preparing an ERTS-B proposal, primarily a follow-on to this investigation, offered a timely opportunity to review the objectives, approach and program plan of this effort itself.

Finally, preparation of a paper for presentation at the GSFC ERTS-1 Symposium enabled review of the project at mid-term.

SUBCONTRACTS STATUS

The Board of Supervisors of the County of Los Angeles having approved the subcontract with GE-Space Division, it became possible for the Test Site Coordinator, Mr. Jene McKright, to make the first visit on the project to Valley Forge Space Center to work on the GEMS early in January. He followed with a second visit in mid-February, accompanied by a County co-investigator and associate, Mr. Lawrence Charness.

The various procedures to go through to complete the subcontract with Mr. Gerald Willoughby, President of OVAAC8 International, Inc. were also followed through to get him on board the team again.

NASA ERTS PRODUCTS TABULATION FOR TEST SITE SR124

Through the end of this reporting period, six cycles of ERTS imagery was received over the test site in the black and white transparencies formats of both 70 mm and 9 x 5 in. for each of the MSS bands. Three of the earlier scenes have been received in the standard color-composite formats, both transparencies and prints, in duplicate.

Non-standard filter-band combination color composites have been obtained for two of the remaining County mainland scenes from the GE-Beltsville Photolab.

Early attempts to make the Diazo individual color transparencies while awaiting the NASA composites have not led to GEMS usable products nor comparable to the set displayed by DI at the GSFC ERTS Symposium.

While the computer tapes (for the test site) have been received for more recent dates than the transparencies, the scene ID's indicate that they often cover areas other than the test site boarder. The only two CCT sets covering the County mainland have been shipped to IARS-Purdue for analysis from the GSFC Purdue Terminal.

WORK SUMMARY FOR JANUARY-FEBRUARY

A. GEMS SESSIONS AND RESULTS

The new year was opened up, on this study, by the first visit by the Test Site Coordinator, Mr. Jene McKnight, to GE-VFSC, for the entire first week. On getting introduced to the operation of GEMS the first day, he was interactively formulating a problem for real time analysis and obtaining resulting patterns that could be preliminarily evaluated. Essentially, a number of quasi-sub-test-sites were defined on GEMS to obtain spectral signatures for the respective

object classes and the entire field of view was then scanned to yield the areas with equivalent spectral signatures. The bi-level thematic maps thus generated on the GEMS TV screen were recorded on the 35 mm camera film. A series of such slides were made from the analysis of the central Los Angeles metropolitan area.

Following Mr. McKnight's return to Los Angeles, the processed slides were sent to him. Projecting the first of these slides on an operational current land use map of the same region at 1:24,000 scale, a match of some of the more readily obvious features was made. In view of this correlation, the pattern from the GEMS-derived slide was traced on a translucent mylar sheet held over the 1:24,000 scale current land use map.

While extensiveness of the correlation between the "Pargyscale overlay" from GEMS-derived slide and the current land use map based on the USGS quads of 1:24,000 scale was described over the phone in some detail, the degree of thematic detail and the geometric accuracy could be appreciated fully by VFSC team members only on seeing the overlay placed on the land use map. Thus, the L.A. Dodgers' Stadium parking lot showed up in the same object class as heavily developed (concretized-asphalted) areas to the southeast, in sharp contrast to the grassy areas to the northwest. Land cover-use abruptly changing across only a four-lane street would show up with corresponding discrete sharpness.

In view of such extensive correlation at 1:24,000 scale 'land use' a la GEMS starting with ERTS transparency at 1:1,000,000 scale, the Cola-RPC staff and management have been rather excited at the potential for honest-to-goodness operational use of ERTS-GEMS products - a situation that was by no means anticipated at the initiation of the investigation.

Some of the excitement of the significance of this result - a finding - was hopefully transmitted to the technical and scientific monitors from GSFC when they visited VFSC during first half of February when the Cola-RPC co-investigators were also east for a second working session on the GEMS. Notes of the discussion on planning vis-a-vis ERTS are attached as Appendix A.

During that session a series of spectral-spatial patterns, corresponding to 'photomorphic regions' within the field of view - central Los Angeles Urban core - was generated in a "nested sub-multiple individual channel" histogram development fashion. Subsequently 'four theme' printout and a "seven theme" multiple exposure slide for overlay and two-sheet computer printouts have been obtained.

Preliminary analysis of these patterns indicates that the internal structure of a large city can be sub-classified to what could be characterized as "near-third" level of land use classification in the extension of the scheme outlined in the USGS Circular 671. This is considered to be a rather significant result by the County coinvestigators. Brief commentary on this result is contained in the Appendix B, which is the paper presented at the GSFC ERTS Symposium just held.

B. DIRECT PHOTOINTERPRETATION RESULTS

The development of direct, 'small-scale' overlays from ERTS prints/transparencies (at contact scale , 1:1,000,000) described in the previous period -- semi-annual report -- has been continued to cover a number of additional themes/topics. Figures 1 through 5 contain a summary of these small-scale overlays. Here they are grouped into

I. Regional thematic overlays ,

II. Urban topical overlays .

A brief discussion of a number of these, illustrating specific points, is contained in the GSFC ERTS Symposium paper of Appendix B. A more detailed discussion of these and the rest of the overlays/recognition maps is taken up in a "CoLAGE Sketch Book" being put together. Hence the Figures suffice here.

WORK PLAN FOR THE NEXT REPORTING PERIOD : MARCH-APRIL '73.

The preoccupation with the ERTS Symposium will continue through early March. Every co-investigator on the CoLA-GE team is attending this symposium , making respective evaluation of the results of the other reported investigations having bearing on the team effort in so far as they deal with :

- a. Geographic coverage of interest to the SR 124 Test Site ;
- b. Interpretations techniques complementary to the GEMS ;
- c. Regional planning / Urban development - oriented thrust .

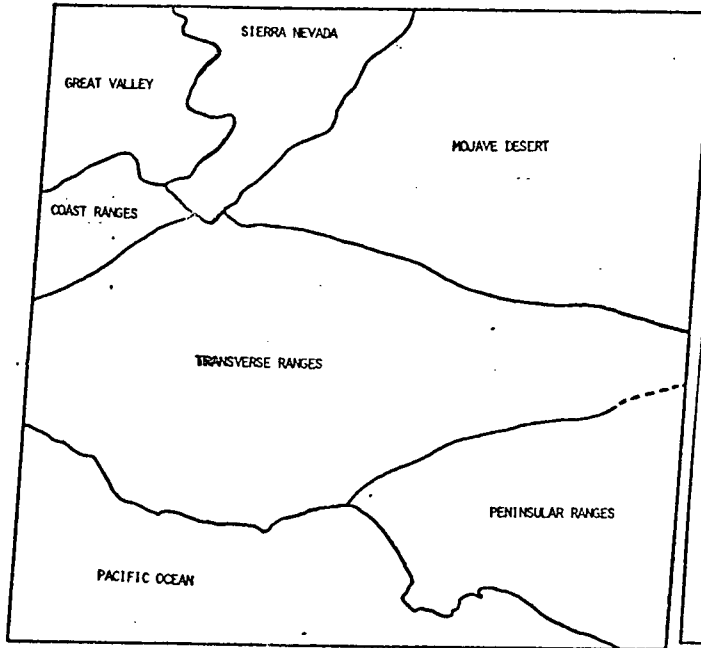
As originally proposed, in the Management Proposal Volume II , Section 6.3.1.5 , a Mid-Project Review Meeting at the L A County Regional Planning Commission's headquarters would be held early during this period. The objectives of the meeting will be to assess the status of the investigation, reporting results to date to the primary & secondary users and to establish requirements for further effort.

While the effort to date has yielded much insight into the data content of the ERTS imagery , especially as 'pulled out' by the GEMS , the development of a generic procedure to apply to other outlying regions within the test site , covering the whole range of applications of interest to the CoLA-Co-Investigators , will be the focus of the activity during this period.

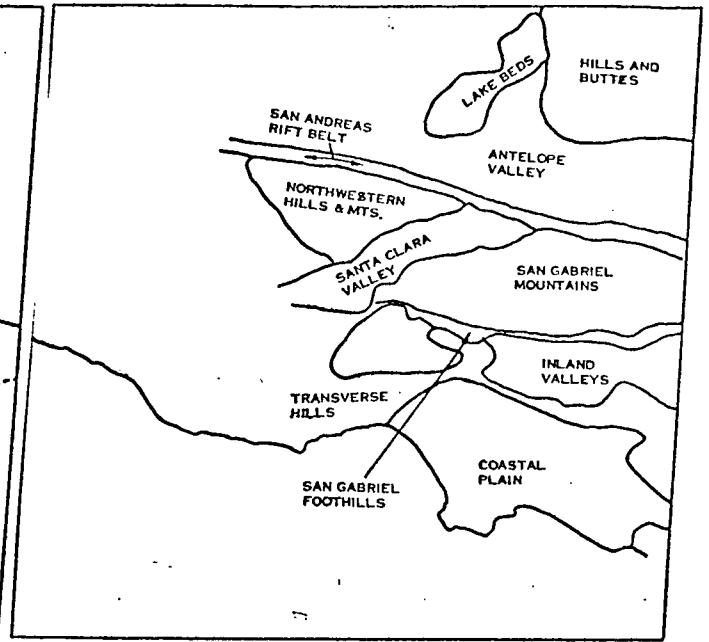
The application of this procedure as well as of the resulting data itself will occupy the investigators in the latter part of this period, to be further evaluated in the following bi-monthly period -- then hopefully involving some of the items/personnel from the Mid-Mission Experimenters' Conference.

The GE members of the team will also be addressing to the implementation of the "digital analyses" portion of the Data Analysis Plan during this period. The arrangements to use the GSFC remote terminal accessing the LARS system at Purdue University have been made through Dr. Bill Alford. The Computer Compatible Tapes for Scenes 1036-18010 , Precession=processed/ scene-corrected and 1090-18012 , Bulk-processed/system-corrected received quite some time ago are being shipped to Dr. Terry Phillips at LARS for re-formatting for use on the Purdue algorithms for themes already developed on the GEMS for these scenes via color-composite transparencies and analysed by the RPC personnel.

MAJOR NATURAL PROVINCES*



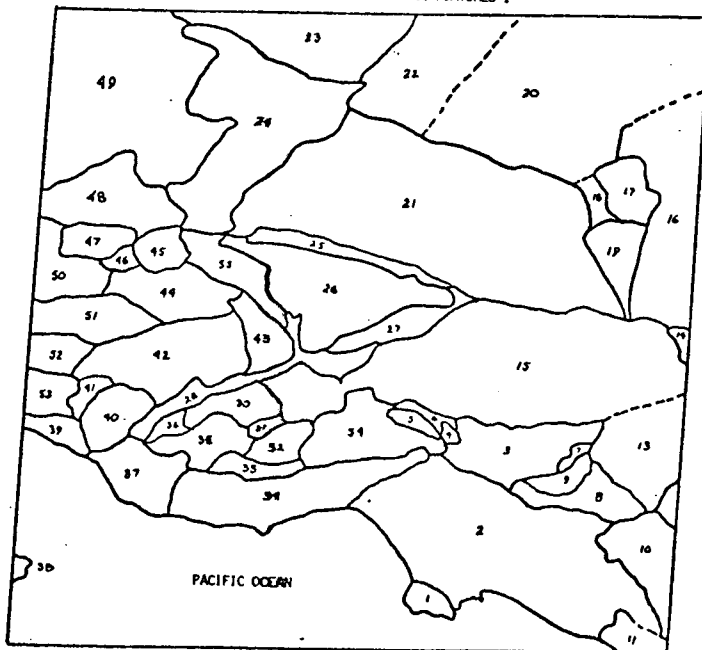
SUBREGIONS AUGUST 10, 1972 IMAGERY



FRAMES 1090-18012, 21 OCTOBER 72

*GORDON B. OAKSHOTT
CALIFORNIA'S CHANGING LANDSCAPE
MCGRAW HILL, 1971, P. 22

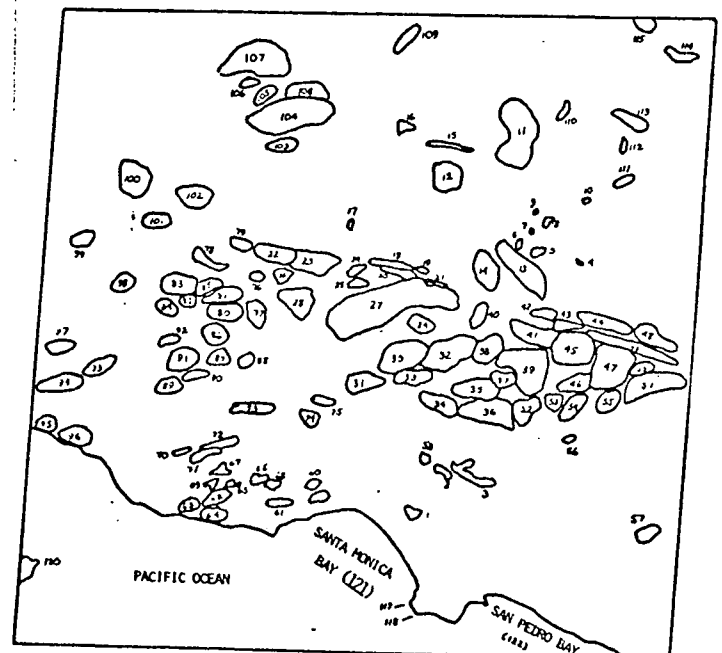
SELECTED TOPOGRAPHIC FEATURES I



FRAME 1090-18012, 21 OCTOBER 72

NOTE: ALL BOUNDARIES GENERAL
DASHED LINES HIGH TENTATIVE

SELECTED TOPOGRAPHIC FEATURES II



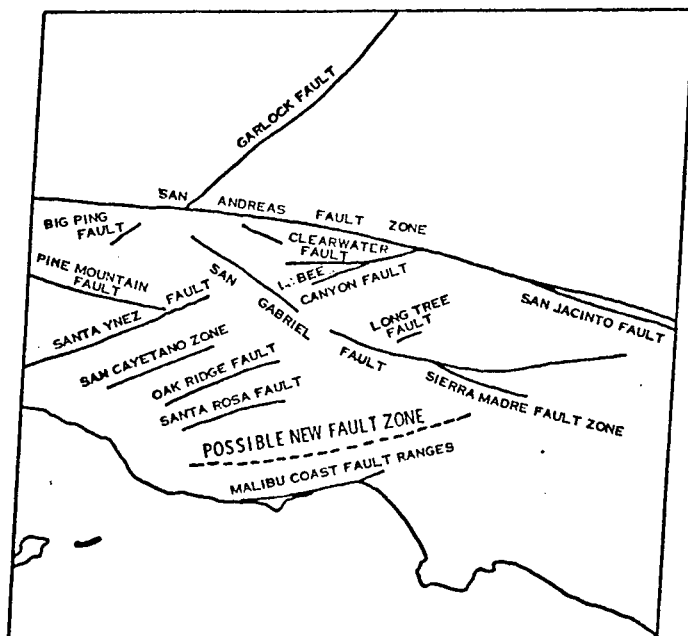
FRAME 1090-18012, 21 OCTOBER 72

NOTE: ALL BOUNDARIES GENERAL

7

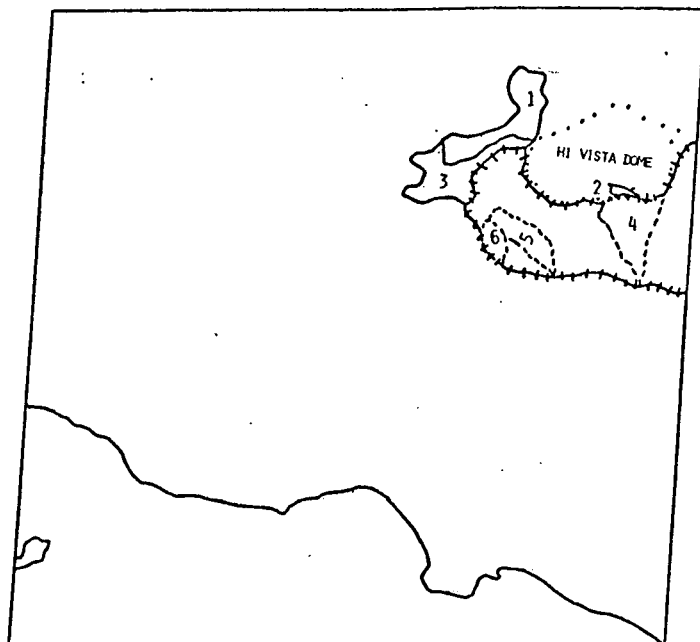
FIGURE 1 . Regional thematic overlay I A .

MAJOR FAULTS AND FRACTURE ZONES



SCENE 1144 - 18015 DECEMBER 14, 1972

SELECTED MINOR LANDFORMS

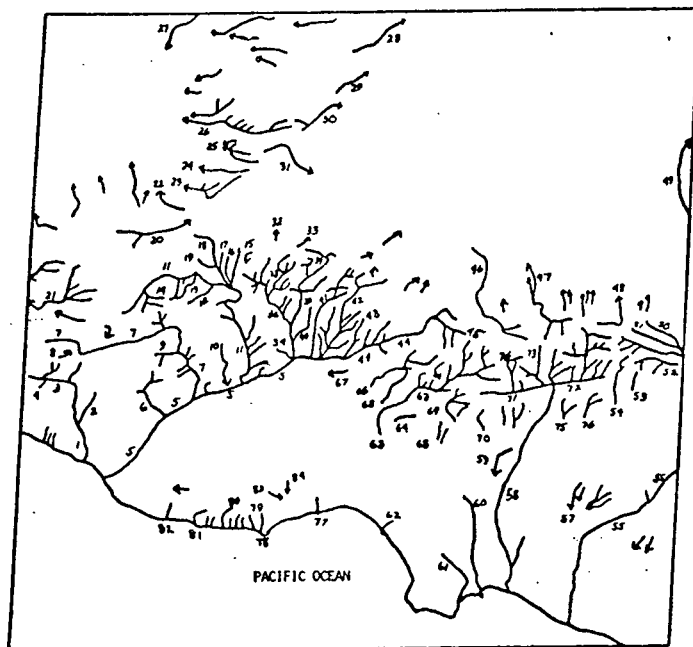


FRAME 1144-18015, 14 DECEMBER 72

--- FAN BOUNDARIES
--- PLAYA BOUNDARIES
... HI VISTA DOME

- 1 - ROGERS-ROSAWIND PLAYA
- 2 - MIRAGE PLAYA
- 3 - OLDER LAKE BED
- 4 - SHEEP CREEK FAN
- 5 - BIG ROCK FAN
- 6 - LITTLE ROCK FAN
- BAJADA BOUNDARY (APPROXIMATE)

STREAMS



SCENE 1090-18012, 21 OCTOBER 72

RESERVOIRS AND WATER FEATURES

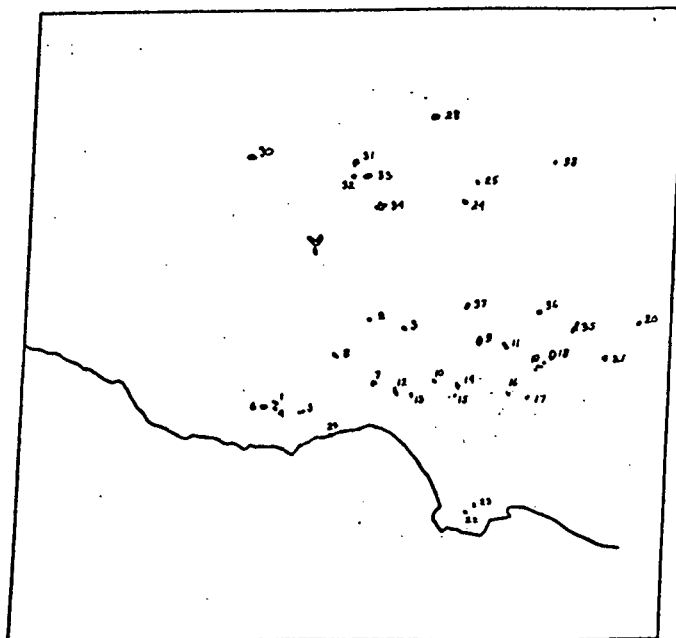
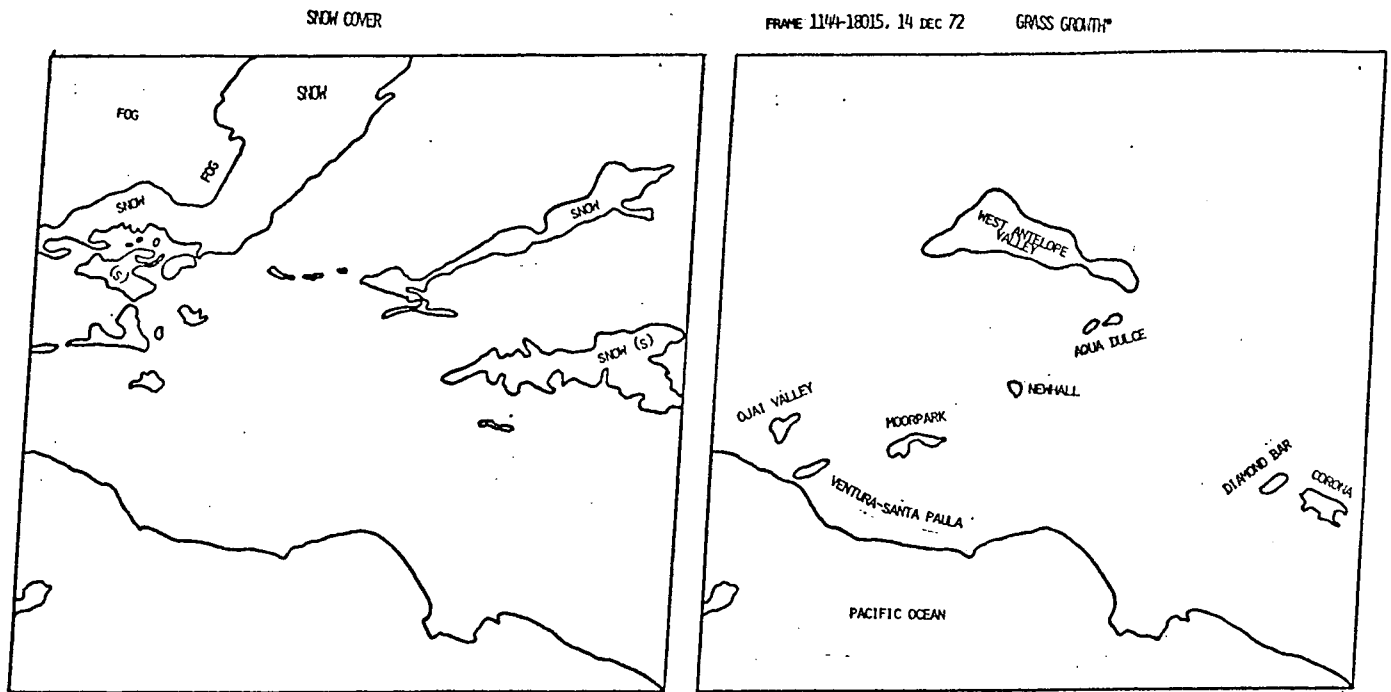
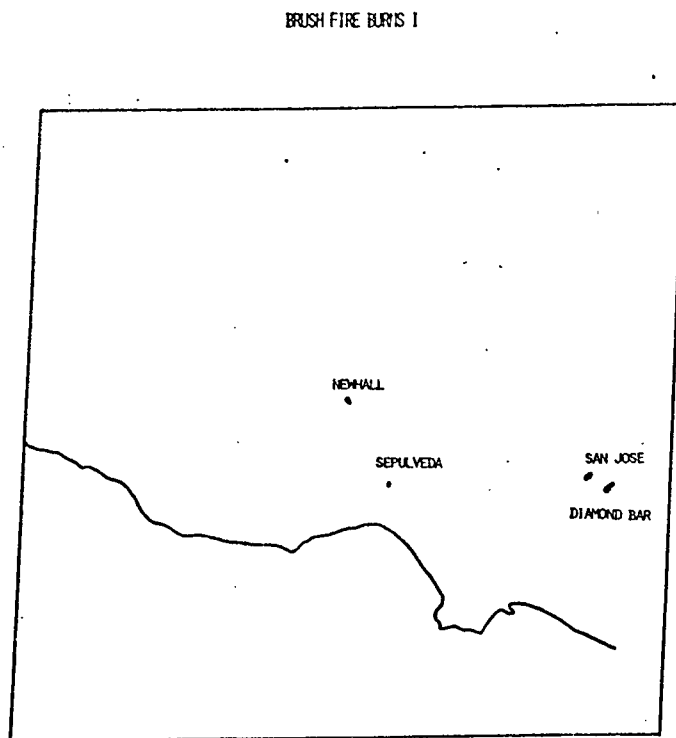


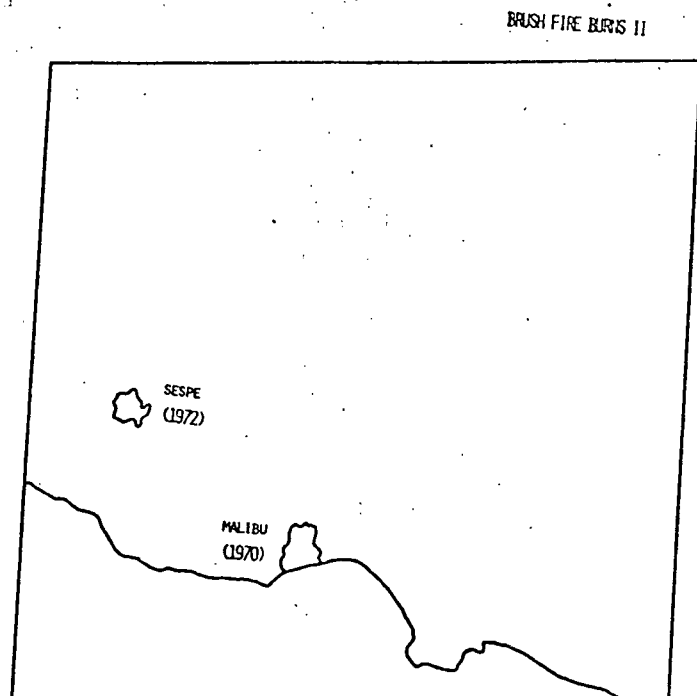
FIGURE 2 . Regional thematic overlay I B .



BOUNDARIES VERY GENERAL
 * NOT CONFIRMED BY FIELD OBSERVATION



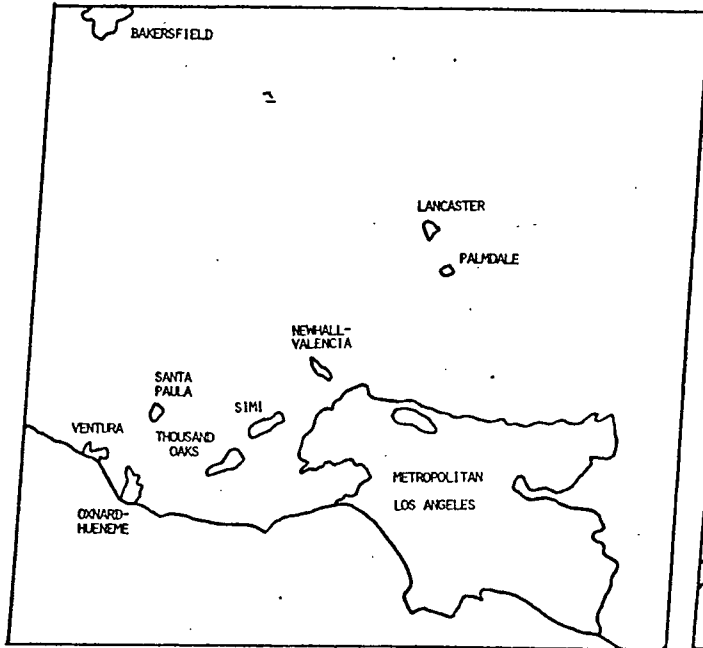
FRAME 1018-18018, 10 AUGUST 72



FRAME 1090-18012, 21 OCTOBER 72

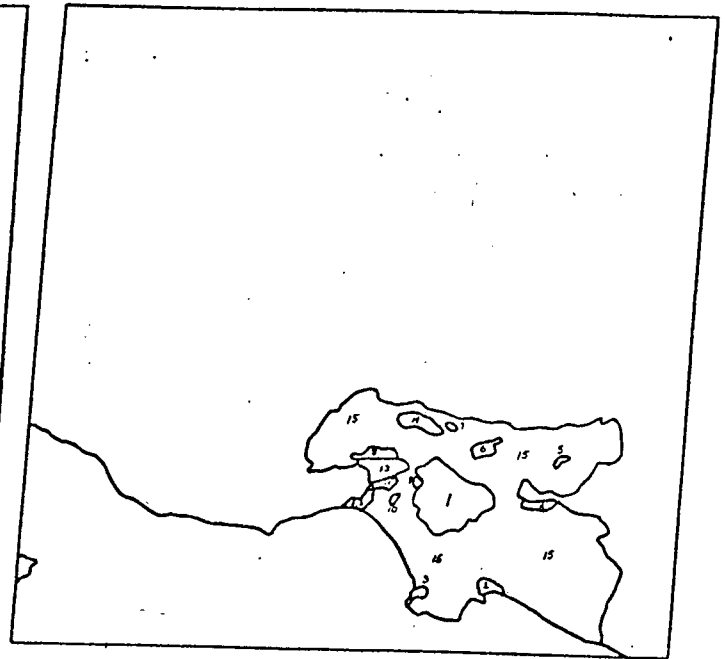
FIGURE 3 . Regional thematic overlay I C .

MAJOR URBAN AREAS



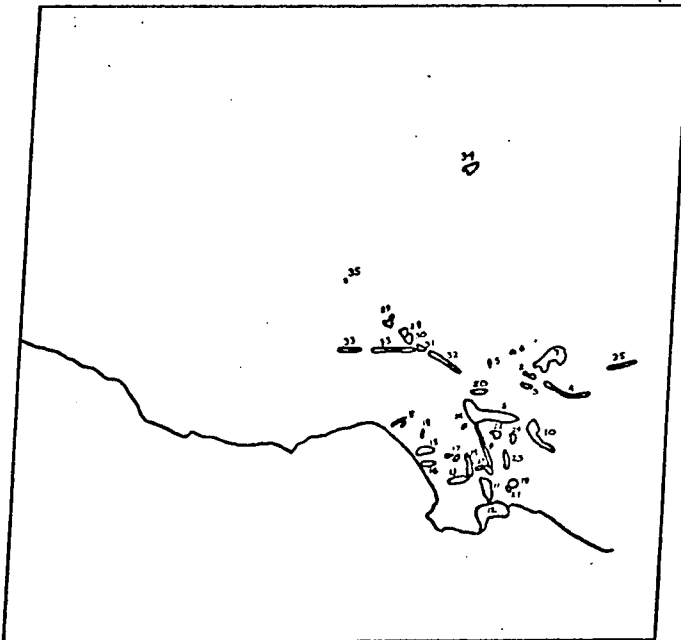
21 OCTOBER 72, NASA ERTS 1090-18012

METROPOLITAN LOS ANGELES URBAN STRUCTURE I



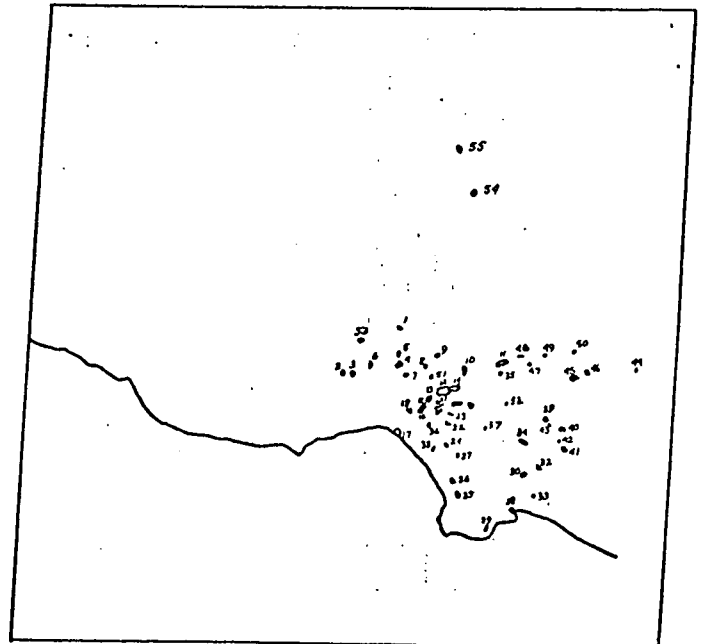
FRAME 1090-18012, 21 OCTOBER 72

INDUSTRIAL AREAS



SCENE 1018-18018 10 AUGUST 72

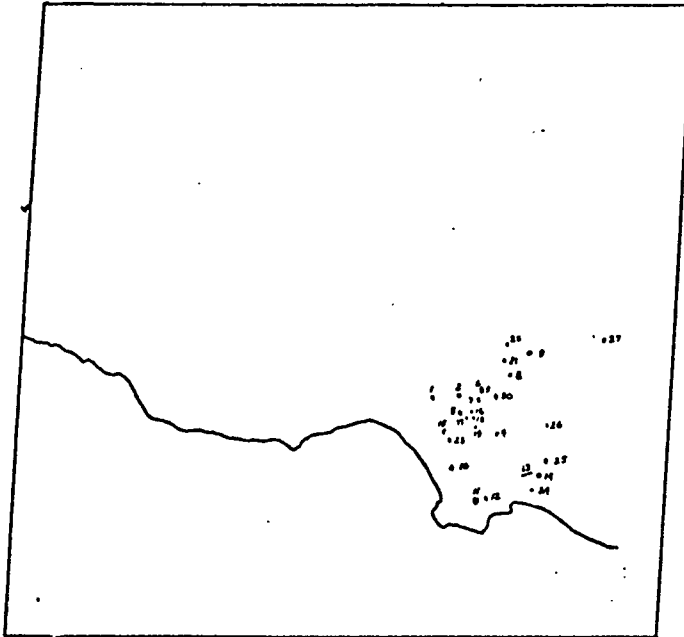
COMMERCIAL CENTERS AND AREAS



SCENE 1018-18018 (10 AUGUST 72)

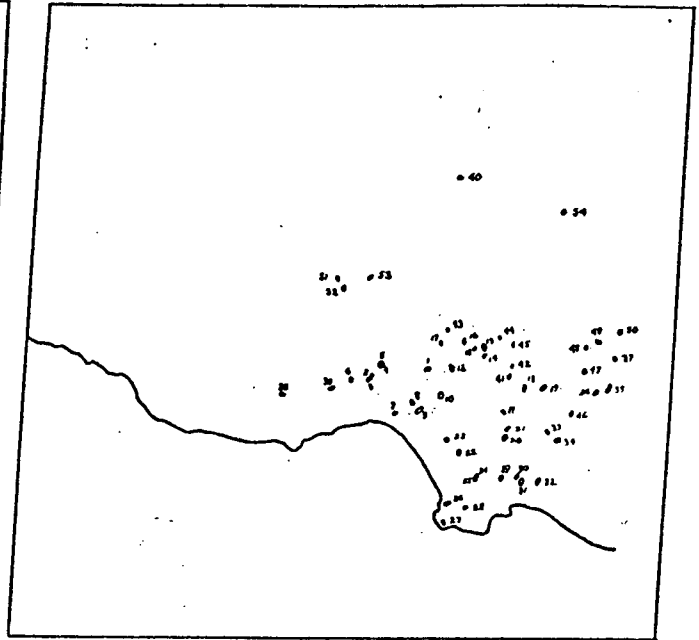
FIGURE 4 . Urban topical overlay II A .

PARKS



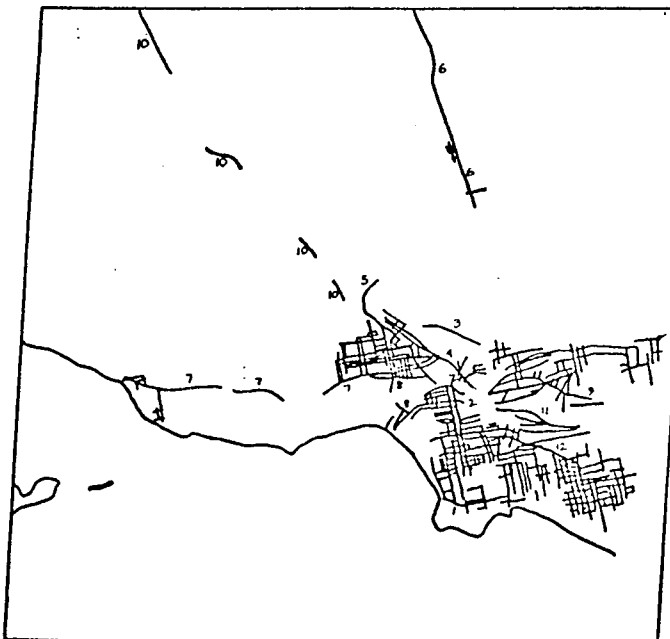
SCENE 1018-18010, 10 AUGUST 72

GOLF COURSES



SCENE 1018-18010, 10 AUGUST 72

STREETS AND FREEWAYS



APPENDIX A

NOTES OF THE DISCUSSION BY JENE MCKNIGHT 2/12/73 (SR 124)

I. WHAT PLANNERS DO AND HOW

A. SCOPE - DICTATES SUBSTANTATIVE DATA REQUIREMENTS

Required

1. Land Use
2. Circulation
3. Housing
4. Conservation
5. Seismic Safety
6. Noise
7. Scenic Hwys
8. Open Space
9. Safety
10. Water & Waste Management
11. Coastal
12. Flood Plains

Optional

1. Recreation
2. Transportation
3. Transit
4. Public Services and Facilities
5. Public Buildings
6. Community Design
7. Redevelopment

B. SCALE - SPATIAL (GRAIN OF DATA REQUIRED)

1. Site
2. Community
3. Sub-regional
4. Regional

C. SCALE - TEMPORAL (TIMELINESS OF DATA NEEDED)

1. Immediate
2. Long Range

D. PLANNING PROCEDURES

1. Problem (definition/identification)
2. Goal Setting
3. Identification of Policy Alternatives
4. Evaluation of Policy Alternatives and Recommendation
of a Choice or Possible Choices
5. Develop Implementation Programs
6. Adoption
7. Administration - feeds back to plan making and reverse

E. SUMMARY OF NATURE OF PLANNING

1. Data Requirements are very broad, varied and voluminous
2. Multidisciplinary in character -- social, physical, & design sciences -- sets policy in all subject areas
3. Deals simultaneously with a nested, overlapping hierarchy of spaces (data must be gathered, ordered, restructured, and reordered in many different ways)
4. Data is needed for a whole range of time scales (immediate to long range)
5. Thus planning deals with relationships among spaces (synopticity) and
6. With change (trend) detection and intervention therein
7. Demand projection (space)
8. Spatial allocation -- a central problem
9. Spatial arrangement -- a central problem
10. Regulation (administrative, day to day decision making is involved
11. Emphasis of physical spatial features

II. HOW PLANNING IS CHANGING

1. Broadening Scope
 - a. More elements
 - b. Social
2. Growing emphasis on the broader scales -- regional, state, national.
3. Growing integration of various jurisdictional levels of planning
4. More stringent constraint on how planning is done -- environmental impact assessment
5. More emphasis on short range and intermediate time scales because of the increasing rapidity of the rate of change
6. Growing emphasis on environmental factors and resource planning
7. Stronger emphasis of implementation of plans (need timely data) (interactive feed-back process)

III. IMPACT OF CHANGES

1. Further expansion of data in each especially resource and environmental
2. Broadening spatial scope
3. More emphasis on timeliness (periodically)
4. Rapidly growing emphasis on the environment

IV. RELATION OF CHARACTER OF PLANNING TO GENERAL FEATURES OF ERTS IMAGERY

The existing and evolving nature of planning is directly and strongly related to be basic features of ERTS imagery; namely,

1. Spatially - knowing deals with physical spatial features
2. Synapticity - planning seeks to cater related
3. Periodic quality - change (trend) detection
4. Multispectral quality - provides large amount of data

V. GENERAL APPLICATIONS OF ERTS DATA TO PLANNING

A. Policy making and implementation in various subject areas especially:

1. Land use
2. Resource conservation and arrangement
3. Open space
4. Water and waste management
5. Urban and regional design

Also to:

1. Housing
2. Circulation
3. Coastal
4. Flood plan management

B. Allocation of spaces for uses and activities

C. Arrangement of uses and activities in space and their integration into systems

D. General urbanization and growth policy

E. Regulation and administration - examples, water management, fire prevention and control, crop monitoring

F. Monitoring (environmental)

VI. INITIAL RESULTS ON DATA CONTENT OF ERTS

Use outline (this is preliminary -- it will change and expand).

APPLICATIONS OF ERTS DATA TO URBAN AND
REGIONAL PLANNING

Data Content of ERTS I Satellite Imagery

- A. Land Uses (Location and Extent)
 - 1. Trend and change detection
 - 2. Project demand for land uses
 - 3. Allocate space for uses
 - 4. Arrange uses in spaces
 - 5. Regulation and administration
 - 6. Define planning unit (spatial)
- B. Urban Design Data
 - 1. Spatial allocation
 - 2. Spatial arrangement
 - 3. Trend detection
- C. Land Suitability Data
 - 1. Spatial allocation
 - 2. Spatial arrangement
 - 3. Regulation and administration
- D. Resource Surveys
 - 1. Management of resources
 - 2. Allocation
 - 3. Arrangement
- E. Impact Monitoring
 - 1. Regulation and administration
 - 2. Allocation
 - 3. Arrangement
 - 4. Trend detection

F. Geological Data

1. Spatial allocation
2. Structure location
3. Regulation
4. Planning and application of disaster measures
5. Define land suitability

G. Shoreline Features

1. Coastal management
2. Regulation

H. Vegetation

1. Allocation
2. Regulation and management
3. Define planning units

I. Physiograph (major land forms)

1. Define spatial planning units
2. Allocation
3. Arrangement
4. Define land suitability

J. Minor Land Forms

1. Define spatial planning units
2. Allocation
3. Arrangement
4. Define land suitability

K. Drainage Features and Hydrography

1. Allocation
2. Arrangement
3. Regulation
4. Management

L. Non Urban Land Uses

See Land Uses

M. Features of Agricultural Systems

1. Management
2. Allocation
3. Arrangement
4. Regulation

N. Land Cover

1. Allocation
2. Arrangement

See Land Uses

O. Urban Landscaping

1. Trend detection
2. Deducing condition

P. Condition of Development

1. Spatial allocation
2. Spatial arrangement
3. Regulation

Q. Adapted - Non-adapted Spaces

See Land Cover and Land Uses

R. Urban Ecology

1. Space allocation
2. Space arrangement
3. Define planning regions

VII. NEW DATA ITEMS OR CAPABILITY

- A. Metropolitan wide urban design data
- B. Urban landscaping
- C. Periodicity
 - 1. Management
 - 2. Change detection
 - 3. Activation
 - 4. Synopticity
 - 5. Direct observation
 - a. Central city and suburbs
 - b. Urban and non-urban areas
 - c. Intensive and extensive uses
 - d. Grading and construction
 - e. Disasters
 - f. Water and forest management

VIII. ENHANCED CAPABILITY

- A. Distinguish intensive and extensive urban use
- B. Distinguish general nature of land cover
- C. Distinguish general nature of adapted and ~~now~~ adapted spaces
- D. Monitoring urban and non-urban (urban grading and new construction) impact
- E. Trend detection
- F. Urban ecology

IX. DISPLAY & DISCUSS MAP (USE B&W AND CIR PHOTOS)

X. HOW PLANNING METHODOLOGY AFFECTED

- A. More emphasis on machine processing of data
- B. More emphasis on systems approach
- C. Greater volumes of data
- D. Environmental
- E. Monitoring

X. (continued)

F. Periodic Review

G. Regional design studies

H. Trend detection from direct observation over abstraction

CONTACTS

AIRCRAFT IMAGERY USE

APPENDIX B .

'FIRST LOOK' ANALYSES OF FIVE CYCLES OF ERTS-1 IMAGERY OVER COUNTY OF LOS ANGELES: ASSESSMENT OF DATA UTILITY FOR URBAN DEVELOPMENT AND REGIONAL PLANNING

S. Raje and R. Economy, General Electric Co., Space Division, Valley Forge, Penna. and
J. McKnight*, County of Los Angeles, Regional Planning Commission

ABSTRACT

Significant results have been obtained from the analyses of ERTS-1 imagery from five cycles over Test Site SR 124 by classical photointerpretation and by an interactive hybrid multispectral information extraction system (GEMS).

The synopticity, periodicity and multispectrality of ERTS coverage, available for the first time to LA County planners, have opened up both a new dimensionality in data and offer new capability in preparation of planning inputs.

Photointerpretation of ERTS images has produced over 25 overlays at 1:1,000,000 scale depicting regional relations and urban structure in terms of several hundred linear and areal features. To mention only one such result, a possible new fault lineament has been discovered on the northern slope of the Santa Monica mountains in the scene 1144-18015, composited of MSS bands 4, 5, 6.

GEMS analysis of the ERTS products has provided new or improved information in the following planning data categories: Urban Vegetation; Land Cover Segregation; Man-made and Natural Impact Monitoring; Urban Design; Land Suitability.

An ERTS scene, 1036-18010, analyzed by GEMS to provide spectrally-derived object class patterns was directly overlaid on a current LA County land use pattern map prepared at 1:24,000 scale. The geometric and thematic content of the GEMS-derived patterns is sufficient for routine use at the 1:24,000 standard operating scale for county and regional planning. The significant point of this converging set of results is that the internal, fine structure of the inner city has been sub-classified spectrally-spatially.

ERTS data analysis has allowed planners to establish trends that directly impact planning policies. For example, detectable grading and new construction sites quantitatively indicated the extent, direction and rate of urban expansion which enable planners to forecast demand and growth patterns on a regional scale.

This new source of information will not only assist current methods to be more efficient, but permits entirely new planning methodologies to be employed.

* Presented on 3/7/73 as paper L18 at ERTS-1 Symposium.

1. INTRODUCTION

The County of Los Angeles is populated by 7 million people and covers 4,083 square miles. Another 3 million people live in the adjacent counties. The Test Site SR 124 is an extremely complex environment both physically and socially. It includes a vast metropolitan area of some 1500 square miles. Its natural environment includes desert, high mountains, and two large islands. The complexity of both the urban and the natural environments of the Los Angeles region was aptly pointed out by Professor Leonard Bowden respectively in papers L5 and R4 during two sessions at this symposium.

Los Angeles County is presently involved in the preparation of a Comprehensive General Plan as required by California Law. A vast amount of data on a wide range of subjects is needed to complete this task successfully. Traditional planning operations are becoming prohibitively time-consuming and expensive. Use of ERTS data in current planning operations will provide a less expensive and more timely product, based on the findings of this investigation through the 'first look'.

The objectives of this investigation are: i) To evaluate ERTS imagery utility for its urban and regional planning applications using the complex Los Angeles area as a testing ground and ii) To ascertain the effectiveness of the General Electric Multispectral Information System (GEMS) by representative analysts/users operation.

The project involves three major parties: NASA, the General Electric Company and the County of Los Angeles. NASA gathers and preprocesses data at 1:1,000,000, 1:125,000 and 1:36,000 scales. GE - Space Division analyses the data and conducts the investigation jointly with the County Regional Planning Commission who interpret and use the data products in its planning program.

The data extraction methodology basically involves classical photo-interpretation by County members on the team and interactive electronic analyses by GE investigators. The processes are mutually strengthened by progressive interaction both by remote means and in person. Figure 1 depicts the information flow for this study.

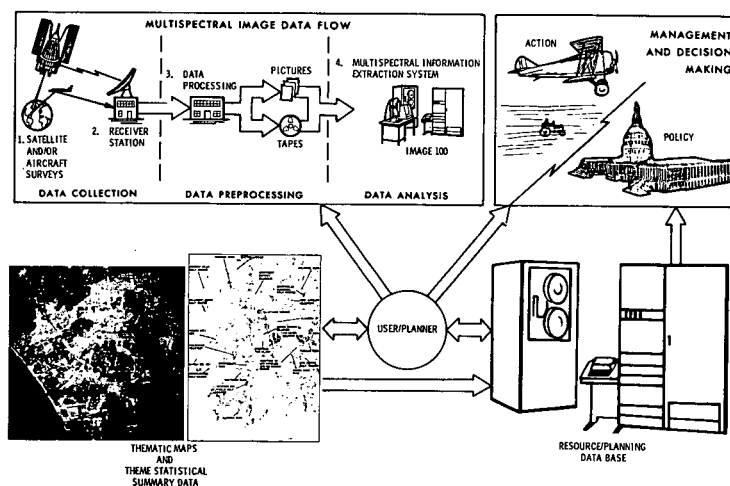


FIGURE 1 Data Analysis Flow

2. SIGNIFICANT RESULTS

The results of photointerpretation of ERTS transparencies at the 1:1,000,000 scale - both black and white as well as standard and non-standard color-composites - by the County investigators are most succinctly communicated in the course of the study effort by an ever-increasing series of theme overlays/recognition maps with exhaustive annotation and commentary. Here it is appropriate to show a selected few of such overlays, as in Figure 2.

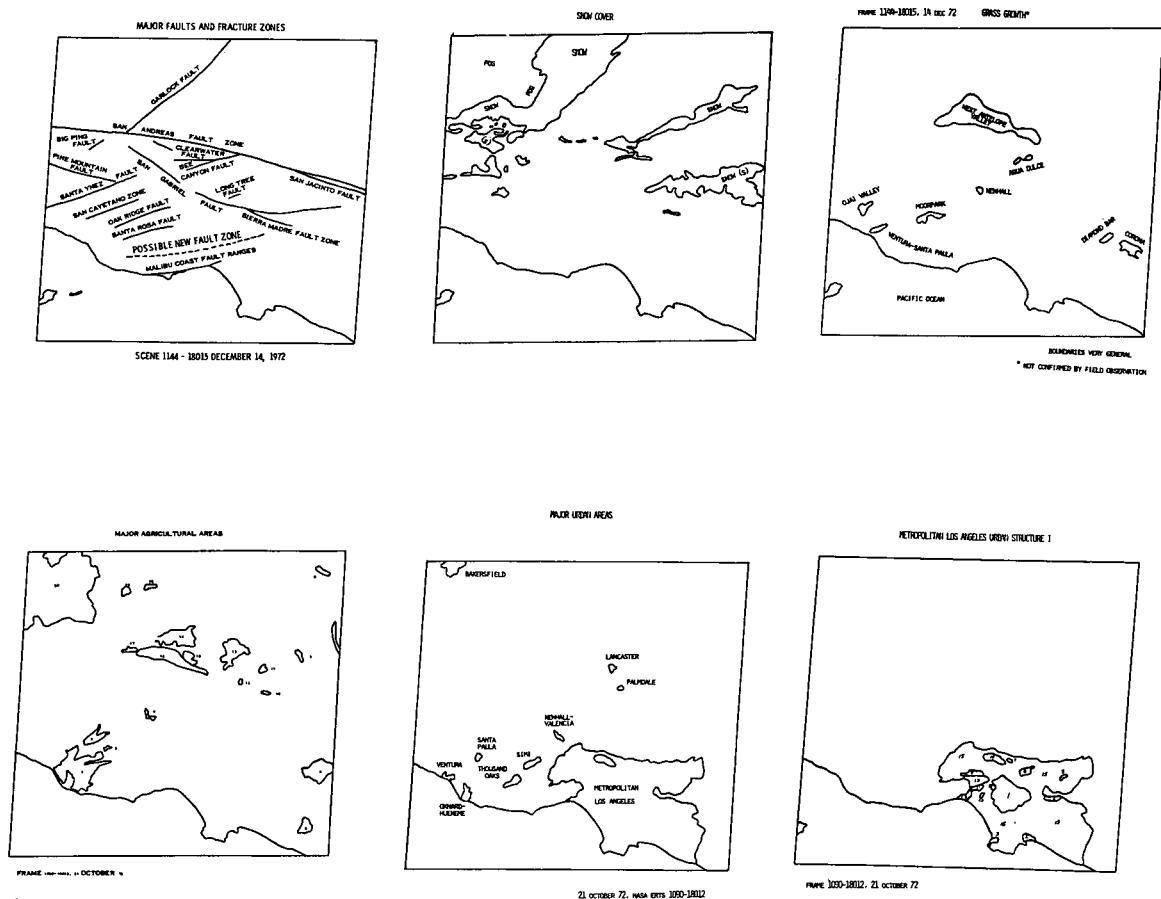


FIGURE 2 An assortment of photoreduced overlays constructed by photo-interpretation of ERTS scenes of the LA County Mainland representing regional and urban overviews of problems for further analyses.

The on-going series of overlays, in addition to serving an orientation reference function, also gives a feel for the surprisingly vast data yield capability of the ERTS imagery. Our analysis indicates that ERTS data content exceeds the detail shown on the standard Army Map Service 1:250,000 scale plastic relief series of maps.

Major Faults and Fracture Zones: A fairly casual visual inspection of the latest CoLA ERTS scene 1144-18015, viz. the December 14, 1972 imagery, in the non-current combination of bands (4, 5, 6) -- composited for us by the GE-Beltsville Photolab -- shows an unusually straight alignment of topographic features along the north face of the Santa Monica mountains. This suggested to the Test Site Coordinator the possibility of a major new fault zone or lineament. The County Geologist, Mr. Arthur Keene, has been assessing this possibility. The ERTS 1 Symposium Program announced a paper by Professors Pease and Johnson titled, "New Fault Lineament in Southern California". The broad pattern they presented in the paper G33 in the 3/6/73 session flanks the fault under consideration here, shown in the upper left corner of Figure 2 by the dashed line - - -. Corroboration of the existence of such a feature would indeed impact land use allocation decision in the vicinity and its confirmed existence would have to be reflected in the mandatory Seismic Safety Element of the County General Plan. It should be pointed out too that in the imminent future, the Santa Monica Mountains will be increasingly the focus of much heated controversy with respect to their land use categorization!

Moving on to another overlay, the same December 14 print reflects major seasonal changes as compared to the previous ERTS scenes with the equivalent center point coordinates. Snow covers (upper center block in Figure 2) portions of the mountains and desert regions. Areas of new grass growth (upper right corner of Figure 2) mostly in the coastal lowlands are also seen for the first time in imagery over the Test Site. The simultaneous occurrence of Spring and Winter conditions illustrate the environmental diversity of Southern California. This is new information from direct observation -- valuable to a number of local agencies concerned with water management, agriculture, recreation and transportation. It is also needed over the longer range by the planning commission to prepare an effective open space and recreation plan which takes into account also the scenic quality. This data will enable regional recreation planners identify areas of scenic quality -- a troublesome problem in scenic quality surveys otherwise made conventionally.

Brush fire burns, not shown in a figure here, show up in the August 10 NASA product E1018-18010 clearly in a four-some clump in the southeast while the October 21 scene E1090-18012 brought out very clearly the Large Sespe burn which later could be just discerned under the cloud cover in the NASA item E1036-18010 of August 28, 1972. The fire was known to have been burned during mid-August. The brush fires in Southern California form one of the major man-induced 'natural' hazards. The large areas burned in a synoptic view should impress any careless fire-bug! Incidentally, data on topography, geology and fire hazard are used by planners in determining the use suitability of land. Suitability judgements are used, in turn, to allocate space for various types of land uses.

Major agricultural areas: lower left corner square in Figure 2. The very considerable variety and complexity of the introduced species of agricultural crops within the test site are readily discernable in all the ERTS scenes on hand to date. A regional corroboration of the statement by Lt. Governor Reinecke of California - that agriculture forms the biggest industry in the State -- can be made in that County in as much as almost 10% of the County area is in agricultural use. As pointed out in the mini-paper in the Preliminary Findings from ERTS Symposium of September 1972 dealing with Antelope Valley agriculture (area 13 in the overlay) the monitoring of

agricultural disinvestment and rural-urban conversion phenomena will be continued in what can be characterized as agricultural sub-systems study. The results of this work and the continued effort on water resources analysis from the ERTS imagery via the GEMS are reported in the study semi-annual report.

Major Urban Areas Intensive Analyses: The thrust of the effort underway in this investigation since the Preliminary Findings Symposium has been and will continue to be on the very complex urbanized regions within the Test Site (lower center, Figure 2). For the first time planners are able to directly observe the entire vast metropolitan area in a single scene on a repetitive basis. This experience is absolutely new and exciting. Again, we can directly see the shape and the general internal structure of the metropolis. An absolutely new data item is the extent and pattern of urban vegetation - a powerful clue to the physical and social segregation of the metropolitan area into subareas. (Lower right, Figure 2). It is necessary to have an accurate concept of these subareas for effective urban policy making and implementation.

Grading and New Construction Sites: Using U-2 aircraft imagery (Figure 3) for quasi-ground-truth we have been able to determine that we can identify from ERTS imagery (previous December 14 scene) all significant new grading and construction sites.

This is an emergent capability of major importance since it means we can cheaply monitor the extent and direction of new urban expansion and estimate the rate of expansion. This means we can now attack head-on a central problem of planning-- trend detection. Knowledge of trend is essential for effective land use allocation

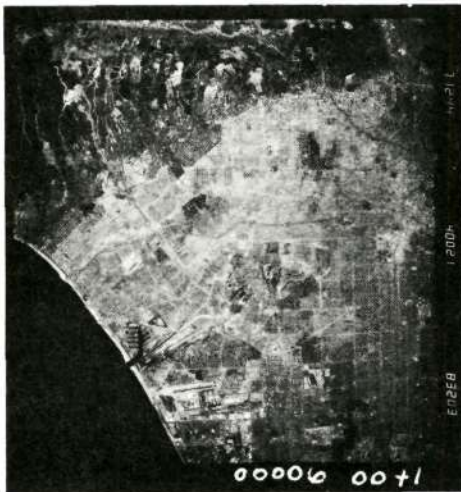


FIGURE 3 One of the Vinten 70 mm frames from Ames, an area 14 X 14 naut. miles covering downtown LA - a mini-sub-site being most intensively studied using the GEMS.

and land use arrangement. The ability to identify new large construction from ERTS imagery means that it is now possible to monitor the extent, direction and rate of urban growth on a nationwide basis using only a single source data. Currently contribution to what fragmented policy in this field is made federally comes from a number of Federal Executive Departments: Commerce, Housing and Urban Development, Interior... formulated much as good deal of regional planning is done -- by abstraction, extrapolation etc. of data acquired from a multitude of sources, over a disparate time period and scale, at considerable expense. Monitoring of national urban growth could be done more cheaply by means of ERTS observation than any other on a very frequent (say, quarterly) basis. This monitoring would almost warrant a Super Cabinet charter!

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Further series of 'urban' overlays, not shown again, were produced for identifying from ERTS imagery, using ground truth for discrimination as necessary, industrial and commercial districts and nodes -- shape and size factors help distinguish commercial from industrial user --; parks, cemeteries and golf courses -- these open space features are most visible on the October 21 scene composited of bands 4, 5 and negative 7.

Urban Ecology: The previous overlays help sort out the urban ecology of the City. The distribution of open spaces, commercial and industrial areas above with textured difference in the urban pattern define the central city areas. Health concentration of urban vegetation defines high quality single family housing areas. These observations have been corroborated by a number of speakers during the last couple of days. Where we appear to have made more specific advance in an analysis of a complex urban area is in the further sub-classification and delineation of intra-city structural patterns of what will be characterized here as intensities of cover-use. The problem we have addressed to is that defined by Mr. James Wray during the second of his two papers -- dealing with the Washington, D. C. metropolitan area over the last decade and half.

Concurrently with the classical photointerpretation, machine analyses utilizing the GEMS have provided greatly enhanced urban analysis capability. An initial experiment involved the measurement of the intensity of red band in a color composite image (8-28-72). The results were displayed for each quartile of histogram distribution of the red intensities. Use of a 35 mm camera and projector -- in Valley Forge and Los Angeles, respectively! -- enabled us after much painstaking and patient tracking and matching to bring this ERTS-GEMS output slide to overlay onto a current land use map of scale 1:24,000 which is our operating scale for general planning work. A careful examination of the underlaid 1:24,000 scale current land use map indicates that the very exciting result is actually a measure of use intensity--a new data item directly obtainable from ERTS and highly significant in urban policy making and implementation. Moreover, these analyses have brought out areas that may be inaccurately depicted on our current land use map (scale 1:24,000).

The next series of experiments utilize the GEMS interactive multispectral signature acquisition/classification techniques to extract various land coverage classes from ERTS color transparencies. Four and seven theme analyses were performed on ERTS image 8-28-72 (scene 1036-18010), bands 4, 5, 7. The four and seven theme results are shown in Figures 4 and 5 respectively

The seven theme map gives a broad and meaningful ecological pattern of the most complex area of central Los Angeles. It separates areas east of the Alameda Street - San Fernando Road corridor from those to the west. It broadly separates the west side low income area from the middle income area. East of Alameda, two other middle income areas (one basically suburban) are broken out. Also major industrial and commercial districts and nodes as well as individual plants are factored out. Major open spaces are recognized as well as several dozen major street alignments defined. The texture (grain) of the urban pattern is greatly discernable. Finally, the color pattern functions like a "contour map" to give strength to edges and boundries in the ERTS scene.

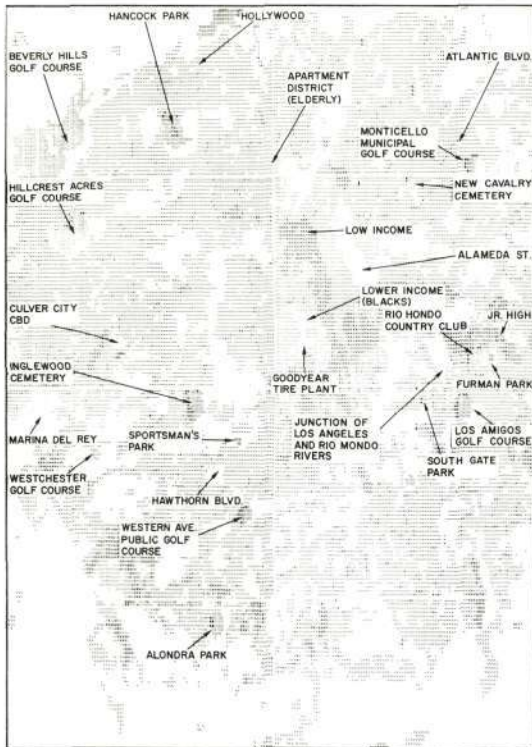
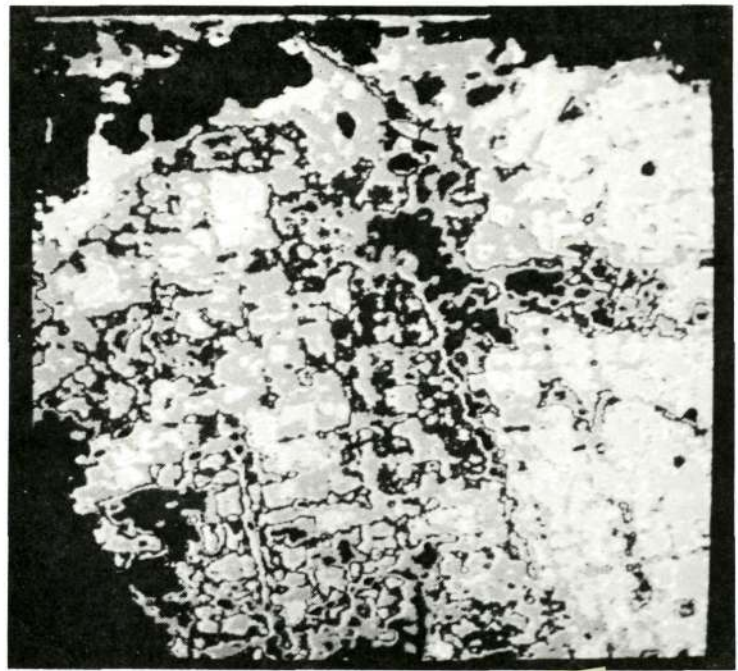


FIGURE 4 Four Theme Computer Printout from GEMS of Central Los Angeles, portion of the scene from Figure 3 above.



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FIGURE 5 Seven Theme TV Display Picture off GEMS Screen from Scene E 1036-18010 at minimum zoom, viewing area same as in Figure 4.

This multiple theme presentation offers the potential for exciting urban design capabilities as well as providing the elements of a general design plan. This would be an absolutely new application of ERTS imagery. Even aircraft imagery is seldom applied to this use.

Preliminary GEMS histogram analyses of the Central LA Core indicates that land coverage can be segregated via GEMS into as many as 12 themes using ERTS color transperancies as inputs. With the completion of the new all digital GEMS/IMAGE 100 in July of this year, ERTS 4 channel digital data can be processed directly -- yielding significantly more land cover segregations. This better theme definition should provide even more effective information to the County of Los Angeles Regional Planning Commission.

A wide range of planning applications are presented above. There is rapidly growing interest expressed in ERTS-GEMS results being obtained by COLARPC by a variety of secondary users. The county geologist has strongly endorsed the use of ERTS for geological analysis. The county forest and fire warden has suggested establishment of a test sub-site and has made a helicopter available to project personnel on 3 occasions just since January 1, having had a first look at the ERTS imagery on hand. Personnel from the agricultural commission have verified the imagery and have repeatedly furnished ground truth. Outside the County, the Los Angeles City Department of Water and Power and the California State Water Resources Board personnel have furnished the surface water acrages as ground truth based on their routine capacity curve measurements of the surface acrages.

Presentations have been made to:

- 1. Los Angeles County Association of Planning Officials;**
- 2. Southern California Association of Governments (SCAG) technical staff;**
- 3. Land Use Committee of the Citizen Planning Council;**
- 4. Land Use Committee of the County General Plan Policy Review Board (GPPRB);**
- 5. Conservation and Open Space Committee of GPPRB.**

A presentation is scheduled on March 12 to the GPPRB - 17 major county department chiefs. Presentations have been requested by:

- 1. SCAG,**
- 2. City of Los Angeles Planning Department.**

The County Parks Department wants to learn if ERTS-GEMS can monitor the condition of the larger parks.

There have been several requests to use ERTS imagery in publications.

3. CONCLUSIONS

Initial results show that data from ERTS imagery can be of immense benefit in the field of urban and regional planning. The impact of natural and man-made disasters can be determined timely and inexpensively.

Data on seasonal changes is available from a single source. The extent, direction and rate of urban growth can be effectively monitored. Generalized land use can be obtained at low cost and rapidly. Information on intensity of land use and urban form, neglected subjects in many planning operations, are readily available from ERTS imagery.

A range of exciting opportunities are opened up in the field of comparative urban studies. ERTS imagery will be widely useful in regional environmental impact analyses. Further analyses of ERTS imagery are certain to extend and deepen the benefits to primary users-investigators such as the County of Los Angeles Regional Planning Commission.

APPENDIX C .

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DEPUTY DIRECTOR

EDGAR T. IRVINE
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JOSEPH K. KENNEDY
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SECRETARY TO THE COMMISSION

February 2, 1973

Mr. Surendra Raje
General Electric Space Division
Valley Forge Space Center
P. O. Box 8555
Philadelphia, Pennsylvania 19101

Dear Suresh:

Enclosed is a report of progress made on the General
Electric - Regional Planning Commission ERTS Project,
from December 26, 1972 to January 25, 1973.

Very truly yours,

THE REGIONAL PLANNING COMMISSION
O. K. Christenson, Director of Planning

Jene S. McKnight

Jene McKnight, Section Head
Policies Planning Section

JM:PG:ei

Enclosure

CERTIFIED MAIL
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General Electric - Regional Planning Commission

ERTS-A Project 124

Phase A Progress Report #6

The following work was accomplished from December 26, 1972 to January 25, 1973.

1. Visit by Jene McKnight (Regional Planning Commission) to General Electric facilities in Philadelphia. Mr. McKnight was introduced to General Electric operations regarding the ERTS Project and to the operation and capability of GEMS. Further attempts were made to test GEMS capacity using sites in Los Angeles County and several types of imagery. Mr. McKnight participated in technical discussions with General Electric Project personnel and other interested persons.

The following items were delivered to General Electric by Mr. McKnight on his visit: approximately 35 maps (agriculture, vegetation, geologic); 1:1,000,000 base map; 4 staff reports on agriculture and land subdivision; report on remote sensing studies; report on Santa Monica Mountains; group of road maps of Los Angeles and adjacent counties; report on Los Angeles Regional Core; sample infrared imagery (Regional Planning Commission and Los Angeles Community Analysis Bureau); water reservoir surface acreage, weather, and haze conditions for November 8, 1972; ERTS imagery overlays of water bodies and drainage features; names of Los Angeles County ground water experts; 1"=2 miles map of select 1 square mile plots; December monthly report (#5).

2. Delivery from GE to RPC of further imagery of Los Angeles County and other areas: approximately 30 scenes from ERTS (color and black and white; prints and positive transparencies); role of U-2 imagery (black and white); 2 boxes of 35-MM slides showing GEMS scenes.

Initial scanning of this imagery was accomplished. Analysis was concentrated on October 21, 1972, color composites.

3. The following items were transmitted from the RPC to General Electric: qualifications of Darryl Goehring for employment on project; copy of "Draft" memo to Supervisor Schabarum relating to ERTS-"B" proposal; letter to Chief Administrative Officer, Arthur Will on possible land use survey of County; local newspaper articles explaining County participation in project.

4. Mapping of the following information on overlays of ERTS-"A" imagery by RPC: major regions, subregions, tentative test sites, parks, cemeteries, transportation facilities, golf courses.

The scene utilized in this overlay mapping was 1018-18010 (10 August-72). Major regions, subregions, and tentative test sites transmitted to General Electric.

5. Selection and mapping of tentative test sites for further investigation. Mapping and description of 13 diverse sites in Los Angeles County.
6. Continued telephone conversations between General Electric and Regional Planning Commission (project coordination).
7. Telephone transmittal from RPC to Lynn Fujii (GE) of select site examples of ecological data.
8. Approval from Director of Planning and Supervisor Schabarum to prepare an ERTS-"B" proposal to NASA and participation in its preparation. Suggested tasks and a cost estimate were sent by Richard Wood (RPC) to General Electric.
9. Consultation with Don Ferrell, County Agricultural Commissioner on farming practices in the Antelope Valley.
10. Initial inquiry into the ERTS investigations of North American Rockwell (coastal process study).
11. Display by the RPC of ERTS imagery to the following interested parties: RPC staff members; American Society of Foresters, Land Use Committee; Thomas Harrowby of North American Rockwell.
12. Field trips by Jene McKnight to check for ground truth information - Antelope Valley, Santa Monica Mountains, Los Angeles urban area.

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LUCILLA BARTHEL
SECRETARY TO THE COMMISSION

March 6, 1973

Mr. Surendra A. Raje
General Electric Space Division
Valley Forge Space Center
P. O. Box 8555
Philadelphia, PA 19101

Dear Suresh:

Enclosed is a report of progress made on Phase A of the
General Electric-Regional Planning Commission ERTS Project,
from January 26 to February 25, 1973.

Very truly yours,

THE REGIONAL PLANNING COMMISSION
O. K. Christenson, Director of Planning



Phil Garofalo
Planning Assistant

PG:ei

Enclosures

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Phase A Progress Report #7

1. Visit by Jene McKnight and Lawrence Charness of the Regional Planning Commission staff to the General Electric Valley Forge, Philadelphia facility. This visit included:

- a. Work sessions to inspect satellite imagery; orient Mr. Charness and Mr. Darryl Goehring on GEMS (General Electric Multispectral Information Extraction System); prepare for a meeting with NASA officials; prepare an abstract for a presentation in early March at Washington, D.C.; and to interpret satellite imagery using GEMS.
- b. Presentations on progress and results of the project to General Electric executives and NASA representatives.
- c. Mr. McKnight and Mr. Charness brought the following items with them to Valley Forge-- overlays of parks, cemeteries, golf courses, transportation facilities (10 August 72 image); infrared frames (1:24,000); Data Content of ERTS I Satellite Imagery (outline); copy of "Hughes News" with ERTS photo; Agricultural Land Use Code; reservoir surface acreage (December 14, 1972); regional core land use maps and index; observations on 35-MM slides of GEMS Display of ERTS I (report); blow-up map of GEMS slides; Alondra and Whittier Narrows park plans.

2. Transmittal of the following items from RPC to General Electric:

- a. Overlays and listings.
Scene 1018-18010 Industrial Areas, Districts,
10 August 72 Corridors, Commercial Centers and
Areas 34

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Scene 1090-18012 Major Urban Areas
21 October 72 County Boundary
Major Natural Provinces
Selected Topographic Features, I
Selected Topographic Features, II
Stream Patterns

95 land use overlays of Los Angeles County.

- b. Comments on the following subjects - "First Look" Comments, Frame 1144-18015, Bands 4,5,6, December 14, 1972; Major Agricultural Areas; Metropolitan Los Angeles, Urban Structure I; Streets and Freeways; Brush Fire Burns I and II; Major Faults and Fracture Zones; General Observations on Usefulness of ERTS I Satellite Imagery for Urban and Regional Planning.
 - c. Memorandum from Jene McKnight to O. K. Christenson, Director of Planning, regarding the visit to General Electric, including recommendations to strengthen the project.
 - d. Twelve copies of the County's Environmental Development Guide.
3. Display of ERTS imagery and/or presentation of ERTS Project description to:
- a. Los Angeles County General Plan Policy Review Board (Land Use and Open Space-Conservation Committees).
 - b. Los Angeles County Citizens' Planning Council (Land Use Committee).
 - c. North American Rockwell representatives.
 - d. Southern California Association of Governments representatives.
 - e. Calvin Hamilton, Los Angeles City Planning Director.

- f. Richard Bigler, park planner and landscape architect.
 - g. 50th Anniversary Celebration of RPC.
 - h. Los Angeles County Geologist Office (submitted for comments and analysis).
 - i. Los Angeles City Planning Department (loan of U-2 imagery for use in report).
4. Transmittal from GE and NASA to RPC of further satellite and U-2 imagery:
- a. December 14, 1972, ERTS scenes of Los Angeles County (transparency and color print)
 - b. RC-10 color infrared at scale of 1:125,000
 - c. Vinten black and white and color infrared at scale of 1:400,000
 - d. ERTS color composite prints of San Francisco, New York-Philadelphia, Washington-Baltimore, Honey Lake, California
 - e. Precision positive transparencies and black & white prints of Los Angeles area
 - f. Black & white prints of Channel Islands
- Scanning and analysis of this imagery was accomplished.

5. A letter from the RPC was sent to NASA which endorsed the submission of Proposal Number N-22854 and ERTS-B participation.
6. Transmittal from GE to RPC of computer maps of GEMS interpretations of August 28, 1972. The RPC has conducted analysis of these maps.

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7. Preparation of an overlay of the GEMS scene in central Los Angeles (1:24,000 scale overlay).
8. GE and RPC preparation for a joint presentation to NASA in early March, 1973.
9. Coordination with NASA-Ames on the planning of an upcoming NASA U-2 flight.
10. Discussion with Mr. Russ Stallings (County Forester and Fire Warden Department) about his offer of the use of a County helicopter on ERTS field trips.
11. Continued telephone conversations between GE and RPC project personnel. These discussions included the subject of a 6-month project report.

3/06/73

PG:ei